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A Complete Index in this issue, of Papers published in the MONTHLY REVIEW during the year 1934.

The MONTHLY REVIEW

Published by the

American Electro-Platers' Society

A Merry Christmas
To You and
Yours

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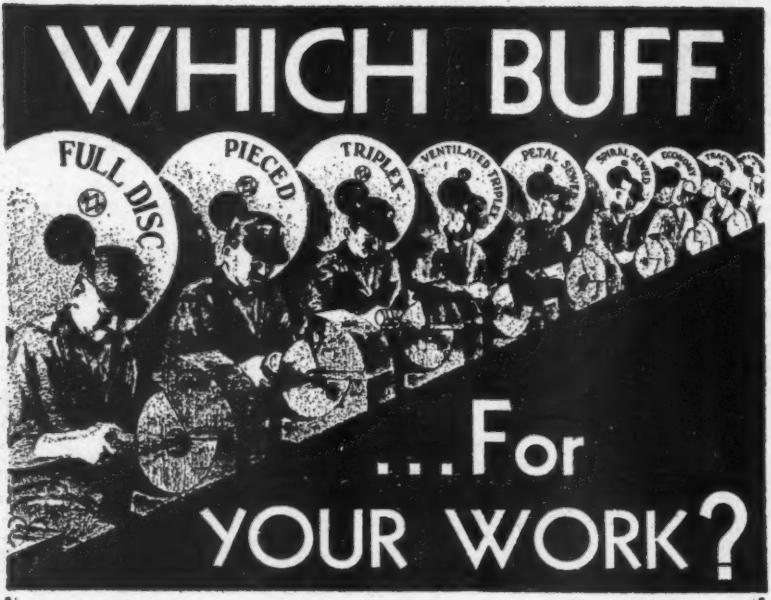

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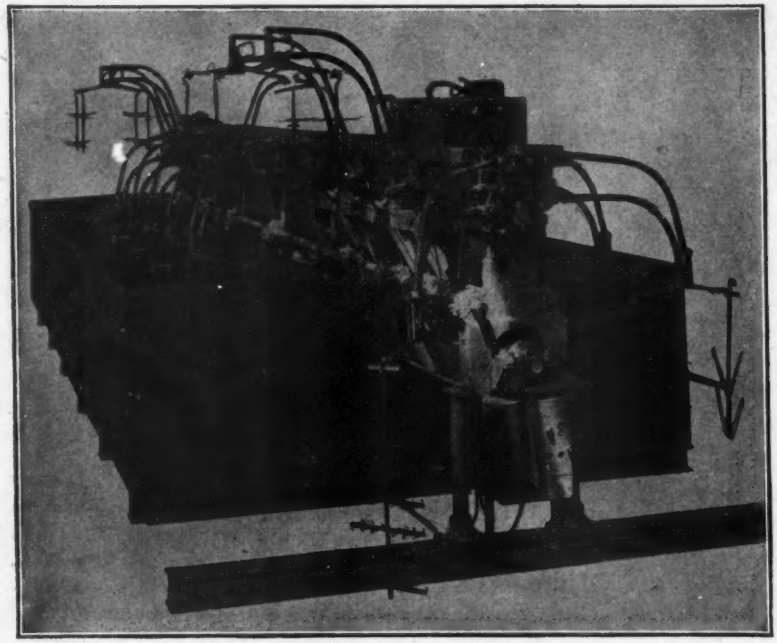

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A Merry Xmas

EDITORIAL

The Membership Drive

MR. Joseph Underwood, Supreme Vice President, and Chairman of the Membership Committee writes: "Shortly after the Detroit Convention this year, President Gilbertson appointed the writer as Chairman and the Secretaries of the various branches as members of the above Committee. Some branches have responded splendidly, particularly Detroit Branch, which sent in seven applications last month. This is a mark for the other branches to shoot at. If the officers and members of the A. E. S. will put their shoulder to the wheel, they will accomplish the same results. Without new blood this Society will be unable to survive, so let us all pull together for the good of the organization and try for at least twenty-five new members in each branch before the close of our fiscal year in June, 1935."

It is needless to say that the REVIEW indorses all that Mr. Underwood says in his letter. There has been a notable gain in membership in most of our branches recently. But we are not all enthusiastic enough to get out and sell our Society to the man who needs us most, the non-member, and there are hundreds of them. Most of us need the faith and vision of the boy who raised a pair of bantams, and waited patiently for the day to come when the first egg was laid. The boy was terribly disappointed at the

size of the egg, and pushed it angrily to one side. Returning later in the day, he removed the bantam's egg, and placed in the nest a large china duck egg, with the admonition written across it — "keep your eye on this and do the best you can."

We should have faith enough in our organization to believe that every real plating shop will be known and trusted in the future because the man in charge is a member of the A. E. S. We need a reawakening of some of our branches and some of our branch secretaries, so that we can receive a report from them once in a while regarding their activities.

We need also a lot of practical as well as technical papers, from our membership for publication in the REVIEW. We have a goodly number of splendid young members who have the ability to write helpful articles. To these, we say that there is no limit to the number of pages in the REVIEW. Anderson Branch, particularly, and all other branches, please take notice. (We have received some splendid papers from Anderson Branch at the recent Conventions.)

Through the untiring efforts of Mr. T. F. Slattery, Chairman of the Educational Committee, we are making contacts with some of the best publications on electrodeposition in France, Germany, Great Britain and Italy. This is accomplished in many cases by an exchange of publications. The fact that the REVIEW is being held in such high esteem by an increasing number of the leading Industrial and Scientific Societies, both at home and in foreign countries, speaks well for the splendid contributions by our own members and friends.

There are still many papers of value read at our Branch meetings, which we would be pleased to publish.

Branch Secretaries please ask the authors of these papers to give them to you for publication. Then mail them to us. We will do the rest. Begin Now.

Copper Cyanide Solution and Its Idiosyncrasies

By ELMER WOODMANSEE
Member Detroit Branch
Read at Detroit 1934 Convention

THIS paper is submitted, not to present so-called standard copper solutions, but an attempt to show the impracticability or infeasibility of them, and to relate varied experiences in operating them.

The writer makes no dogmatic claims as to proof of his beliefs or opinions, neither does he resent criticism, constructive or otherwise; in fact, welcomes plenty of it and believes all papers presented before the A.E.S. should be picked to pieces, discussed thoroughly, and the majority of facts or opinions thereby obtained, that will make any and all members of this Society better platers, and able to build and maintain the best solutions for the deposition of all metals.

Some time ago our beloved and now deceased fellow member, Dad Liscomb, who, in my opinion at least, did as much or more than any Society member to make better platers of all of us, read a paper on iron present in solutions of copper cyanide containing chlorides, that finally resulted in disintegration of the steel plating tanks when used as the anode.

While I had, for years, used tanks — always connected to the anode rod to prevent deposition of copper by eddy currents — without ever having any trouble in that respect, it showed possibilities of trouble never before even considered by me.

If I am not mistaken, an article was printed in the very same issue of the journal advocating the use of 3 oz. of table salt to the gallon in a cyanide copper solution.

Here were two papers that were directly opposite in facts or opinions, that might mislead members.

In the February issue of the 1934 REVIEW the following question was asked: "Is there any advantage to use a cleaner with a copper strike solution for cleaning steel or brass before plating? Will there be any peeling if this method is used instead of plain cleaner?" Answer: "Yes, it is an advantage to use a copper strike

cleaner as it helps you to see if the article is clean and gives better adhesion. There is no danger of peeling due to this method."

I have seen plenty of peeled work, that had been run through a copper strike cleaner, where the metal content was allowed to increase too much in proportion to cyanide (free) and insufficient cleaner used. Would it not have been far better to have amplified that answer, and pointed out the care necessary in any cleaner or combination of cleaners, to be sure to keep the cleaner and cyanide content high, with full dynamo voltage, and only metal enough in solution to deposit a thin film of copper not too quickly, and only when thoroughly clean; to dump copper strike frequently and making it up entirely new?

We cannot be too careful in advising our fellow members and should point out the pitfalls as well.

Correctly used, I believe there is nothing better to use as a second or third cleaner, than the copper cleaner strike, or produce better adhesion on steel, iron or brass, the latter of which may contain five or six metals, and I have licked many a cleaning problem since chromium came into general use in the plumbing supply and many other manufacturing lines, but I do not believe it should be the only cleaning solution used, but rather as the final cleaner, preferably after a soluble soap soak, electro cleaner process.

Since chromium came into such general use, we have all had to change our ideas and revamp our methods to secure a satisfactory adhesive plate that would withstand the stress of chromium deposition. For example: Consider the process evolved by Madsenell; he certainly left nothing to chance in his endeavor to secure adhesive plating and has certainly achieved very satisfactory results.

The writer has also seen plenty of grief in plants endeavoring to plate copper over nickel, buffed or otherwise; here the copper strike has had great success, especially if the cleaning is thoroughly done, then run through a cyanide dip (strong) to remove any cleaner stain or residue, then hot water rinsed and plunged into a 10% hydrofluoric acid dip long enough to secure a good bite before finally rinsing and copper striking and replating. Personally, I believe the tendency of the metal content to increase rapidly with considerable free cyanide present, and large anode area, thus requiring addition of more cyanide, which builds up the metal content again, and so on, *ad infinitum*, is one of the

largest problems in the proper regulation of copper cyanide solutions, particularly in conveyor tanks, where bulky and long objects, such as windshield frames, small in area, light in weight, but 5 feet long 1½ to 2½ inches wide, with two right angle ends. Steel anodes were intermingled in an endeavor to control, but the plate seemed thin in spots, solution continued to increase in metal content, the free cyanide seeming to attack the remaining copper anodes with additional energy, apparently.

What is perhaps a fool idea has occurred to me, and with which I have been unable to experiment except in a copper strike solution where it did control the metal content in the limited time I operated it, is to have the anodes insulated from the tank in the usual way, except a very small rod to tank to prevent copper deposition as before stated, a connection from the positive busbars, using a double-throw switch large enough to carry amperage needed, so that you could use the anodes as anodes or cut them out and use the tank only as the anode, thus depositing from solution only, until metal content was reduced sufficiently, then revert to copper anodes; this should do the trick: advise using anodes 3″ wide and about the same distance between to allow free circulation from the tank. No positive assertion is made that this is the solution, but it is given for what it is worth, and I sincerely believe it can be made to work, but it must be used with an open mind, and if you don't think it will, it probably will not. Any suggestions for improvement will be heartily accepted.

Another idiosyncrasy is where a copper solution of indefinite origin and age would pit very badly at 140° Fahr. on windshield frames only, and not at all at 120° Fahr. Small parts did not pit at either temperature.

It could not have been caused by too much carbonate content, as an entirely new solution made up as follows:

Sodium Cyanide	3 ozs.
Copper Cyanide	2 ozs.
Rochelle Salts	2 ozs.
Sodium Carbonate	2 ozs.

did the same thing, all other conditions apparently being equal, except there was a much heavier and rougher plate at the higher temperature.

Due to corrosion of rheostats which were directly above the tank, it was not possible to accurately check the amperes flowing, but the same number of switches were used on the rheostats in all

cases, when plating windshield frames. Soldered connections were not used to wires leading to ampere meter, which corroded and caused faulty reading.

Barrel plating of zinc buttons with copper, caused considerable grief; endeavors to deposit the metal at high amperage resulted in a very heavy deposit not adhesive, actually chipping off when rolled in lacquer after sulphidizing. This trouble was overcome by Mr. Edward Klatzke.

Copper cyanide solutions (I mean production solutions) should be used to deposit metal only (in my opinion), never used to remove grease or to facilitate and remove grease, which should be removed in any of the cleaners manufactured by the trade. These concerns spend lots of time and money in research work in these lines, and have trained representatives in the field sufficient to take care of our requirements, and amply able to cooperate and aid the manufacturers and platers, if given the opportunity to see the work, type of grease or oil to remove; a view of the working equipment, and fa air break. Don't misunderstand me, I am not paid; never have been; neither has any concern ever attempted to pay me for these suggestions. Neither am I suggesting or advancing that any concern or anyone turn over their production plating line to any cleaning concern without thoroughly investigating and trying, on a small scale, and expanding use as long as favorable results are being shown. I just believe it a common sense idea, have myself been aided and advanced in knowledge of the right kind of cleaning methods by these men and am, therefore, willing at all times to listen and cooperate with these gentlemen when necessary, my firm belief being that while we can have too little knowledge, we never can have too much. Credit should be given where credit is due.

Just recently, a case of a new copper solution just made up and refusing to plate, was brought to my attention by a brother member of the Society, that rather suggests that a person should never attempt to diagnose the trouble without viewing the equipment installation. The solution had been made up as follows:

Sodium Cyanide	9 ozs.
Copper Carbonate	4½ ozs.

I do not know if sodium carbonate had been used, but no mention was made of it. Now, as it required two (2) ounces of sodium cyanide to dissolve one (1) ounce of copper carbonate, if none of the

carbonate had been converted to the oxide in the drying process by heating, or if hot water had been used to dissolve the cyanide, then the copper carbonate added very quickly, the black oxide might have been formed. These and other suggestions, all that a person would think of on short notice, the member mentioned before, found, upon arriving at the installation, that very small copper bars had been used as the leads from the busbars, and when the proper size to carry the amperage, were installed, the solution plated without any additions; although in use, free cyanide would be necessary addition to dissolve the single copper cyanide forming on the anode, thus forming the sodium copper cyanide solution and sodium carbonate or other so-called conducting salt for conductivity.

Here is a case that proves all conditions possible should be considered before attempting to solve any plating or other problem:

I was called in by a large motor car company some years ago to see if I could better their conditions, and I learned that the copper solution used for plating cam shafts for heat treating was causing trouble. Upon investigation, it was found that anodes and solution were so covered with grease, and the solution so contaminated with it, it was a wonder the solution plated at all. They were depending upon the one solution alone for removal of grease and rust and plating. Upon installation of a good electrical cleaner operated at high temperature and amperage, their plating cam shaft trouble vanished like magic. So that is one reason for my belief previously stated an object lesson. Many such instances have corroborated this belief.

While with a Dubuque, Iowa, plumbing supply manufacturing concern in the earlier chromium days, I took charge just after the chromium plating equipment had been installed. They were endeavoring to plate it over nickel and were losing about 90% of attempts, and were in an awful jam, with badly pitted nickel as well. The licensee experts were having trouble there and elsewhere and finally advised us to chromium plate direct on the brass to reduce losses. I asked the expert, a splendid plater, by the way, if he thought a copper strike would help. He said, "By all means, no." I, however, installed a 20-gallon copper strike with high caustic cyanide, and plenty of sodium carbonate, using this as a second cleaner, with practically 100% results, until the next visit of the expert, when he told us all the plumbing concerns

were using it with good results. We then installed a copper strike large enough to take care of full chromium production, had a soap soak tank to loosen the buffing dirt in a 15-minute soak. The work was colored very highly in the brass; no tripoli dirt left anywhere after coloring, then rinsed and cleaned in an electric cleaner, using —

3 ounces of Trisodium Phosphate
3 " " Sodium Carbonate
2 " " Caustic

in the electric cleaner. The same in soak tank, minus the caustic, because of long immersion; then through the copper strike as a third cleaner; all in one cycle, with proper rinsing between, of course, with practically 100% results. While I was highly elated I still was not positive this was the sole reason, and again using the 20-gallon container, tried the same cleaner formerly used, containing a laundry soap, and again had some rejects, which I believe was due to a soap film that did not rinse freely but was partly removed by the caustic copper strike, and found this was the real reason, as I have since plated thousands of pieces using only one cleaner and no copper strike, with very good success, but I have never used laundry soap since and never will.

A concern in Kansas had just started in the electrical devices for household use, such as electric irons, toasters, percolators, etc., and were having about 95% losses on percolators with an antimonial lead spout and a copper body. Through the plater, a chemist and a personal friend, I learned of the trouble and having had four years' experience in this line, I was sure I could help, so went to work with him to lick the job.

I had noticed an article in the MONTHLY REVIEW some years before how to plate on antimonial lead objects, using a two (2) ounce to the gallon Sodium Cyanide solution for removal of oxide, then rinse and plating direct with nickel. This met with no success, but by using this after electrical cleaner, then brushing with lime, rinsing and immersing in a sodium carbonate-trisodium phosphate, no caustic copper strike, then rinsing and hanging in nickel, no acid dip used, all trouble ceased, results were practically 100% good. Process had to be watched very carefully and copper strike renewed frequently, but it was well worth it.

Before leaving the concern, I suggested using a soap soak, very mild, and perfect rinsing, and the process is the best they have found, and in use to this day.

Score another success for the copper strike, I am certainly sold on the copper strike, but we must use the greatest of care for the human element has to be considered, and nothing is fool-proof.

While this paper has seemed to be a boost for the strike, it is in line with the title.

I would now like to digress from that subject and offer a few suggestions that perhaps may be of interest to all.

The present tendency in the larger plating installations, is very large full automatic units; this, however, has some serious disadvantages, such as operating one-quarter to one-half capacity in slack periods, and if anything goes wrong in solutions, all production must be stopped until rectified or dumped and a new solution made, which also takes time.

At the risk of being called crazy, and I am more than willing to be considered crazy, in that event — would it not be better to split the total capacity into two units of half capacity. This would enable the concerns to start up one unit at a time; when slack, keeping the remaining solutions in perfect shape, and when needed, started up, or in case of solution trouble, shut it down, and operate the other unit, which would give you at least one-half capacity until other solutions were brought back to normal. This would also obviate the necessity of dumping a 4,000 to 10,000 gallon quantity because it plated pink copper, what-have-you or "sumpin", production held up, etc., although the initial cost would be slightly higher, and more floor space required. No sarcasm is intended, nor do I even question the decision to dump a tank that is holding up production, for production stoppage means a total loss until resumed; and who has the right to question the wisdom of another man's decision under those conditions.

Many large concerns I have been in have insufficient cleaners to clean the work in large volume satisfactorily, and polishing operations not inspected carefully enough previous to plating; and many dollars would be saved in these plants if all poor polishing passed by inspection department, should be charged back to that department if improperly inspected. I grant you, this would cause immediate tightening of inspection, and decrease in production, but properly worked out together with best interests of all as a complete unit would result in a surprising all-round efficiency eventually. In other words, it might be better to pay the polishers a little more money to do the work right in the first place, and then the inspection see that they do it, play no

favorites whatever, for it is human nature to skin work if they can get away with it. Work, particularly steel and iron, is very hard to inspect, when covered with grease, and a small electric cleaner to remove that grease is a handy thing to have in an inspection department, or wiping with a gasoline soaked rag on articles picked at random from each lot, would show the percentage of poorly polished work very readily, and old-time polishers, too old to work at polishing, could be given this work, their eyesight carefully checked, spectacles furnished at cost, then held responsible for results.

Perhaps none, or some, or all my suggestions will be used, but I feel that I have performed my duty in making them; they are made without animosity and only in the hope that any adopted will result in producing better grade of work.

I have stressed the lack of sufficient cleaning before plating; I have also found several instances where too much cleaning resulted in poor work. A large Ohio concern making hub caps, radiator seals and emblems, etc., were losing about 75% of their small seals that were processed very cleanly, highly color buffed, and really needed very little cleaning. Their process was to immerse in a still cleaner for a few moments, swab with a soft brush to prevent scratching with still cleaner solution, then placed in large dish pans for storage, scratch-brushed all over with slow running scratch brushes with a cleaning solution used over and over by pumping through pipes to a tank from where it was fed through pipes by gravity (solution never changed), again stored in pans under water until racked and plated. This allowed considerable trouble from oxidation and contaminated scratch-brush cleaner liquid. In other words, too much cleaning and storage. The solution was visable at first glance — a new cleaner was made up, work brushed or swabbed in it, put into pans for storage, just enough to allow continuous operation. Work was now racked up, re-immersed in still cleaner after racking, rinsed, strong cyanide dipped, rinsed and run through copper cleaner strike, rinsed and hung directly in nickel bath, plated the usual time, buffed, run through cleaner for chrome, and results were about 98% perfect.

In conclusion, I would stress the advisability of fully or at least 95% saponifiable polishing and buffing compounds; while their initial cost is two to five cents per pound higher, the ease of cleaning, and lowered production costs and losses, when properly used,

will repay many times their initial cost. One case in particular: a steel hub cap made by the same Ohio concern had a very sharp stippled background; petrolatum compounds used in buffing and allowed to stand some time before coloring were almost impossible to remove. Brushing for ten minutes with high test gasoline, with a still tampico brush, after three to five minutes in a good cleaner on a single piece, sometimes failed to clean. Saponifiable compounds after buffing, and standing the same time or longer, were readily removed after a 30-second immersion, then brushing a few strokes with cleaner — operator could clean 50 pieces, to 10 of the unsaponifiable. Just figure that percentage difference — there's your answer.

I thank you for this opportunity, courtesy and consideration. (Applause)

CHAIRMAN BARROWS: Are there any questions or comments on Mr. Woodmansee's paper?

DELEGATE G. M. COLE: I do not know what the author had in mind when he spoke about putting the steel tank in circles with his copper cyanide solution, stating that it would relieve the anodes in the tank when that was going on. If he just used a double throw switch and the anodes were still in the tank, it is possible that the current would flow from the steel tank to the anodes and from the anodes to the work. The anodes, while hanging in the tank, would be a series of electrodes, and would not accomplish the object he had in mind, that of reducing the metal content of the solution.

If, on the other hand, the anodes were removed, I should think that it would be a better way to do it for a short period of time.

DELEGATE WOODMANSEE: I grant you that it would be better to remove the anodes. It would be easy to remove them. That is a minor consideration. It has to be worked out. There is nothing definite about this; it is only an idea, that is all, and I appreciate any suggestions.

That point was raised by a brother member of the Society. I did not think it would happen, I am frank to tell you that. It may.

What are you doing personally to boost the Membership Drive?

Concentrated Cyanide Plating Baths

By L. C. PAN
U. S. Research Corp.
Long Island City, N. Y.

Read by B. F. LEWIS
At the Detroit 1934 Convention . . . . . .

IN an article published by the writer in *Metal Cleaning and Finishing*, March and April 1933, entitled 'Concentration of Cyanide Copper Plating Solutions,' a striking relationship was discovered between the concentration of copper cyanide and the operating qualities of the cyanide copper plating bath, such as the current efficiency, bath voltage, solution resistivity, anode and cathode polarization, and character of deposit.

It was found that a solution containing one mol of copper cyanide (63.6 grams of copper per liter or 8.5 ounces of copper metal per gallon) showed the most desirable qualities. For instance, that particular bath as described in the above referred to article showed an anode efficiency of 98% and cathode efficiency of 81%. The free cyanide content of that particular bath was 1.9 oz./gal. (14.7 g/l), and the sodium carbonate, Na_2CO_3, content 41 g/l, or 5.5 oz./gal. The concentrations of these latter two ingredients were arbitrarily chosen from data available on cyanide copper plating solutions of much lower concentration (see *Metal Cleaning and Finishing*, November and December 1931, pages 585, 651, and 658; also January and February 1932, pages 19 and 81). This paper tends to give further data relating to these two ingredients while the copper content of the bath is held constant at one mol (equivalent to cyanide copper content of 12 oz./gal.).

Starting out with a solution containing 12 oz. of copper cyanide, dissolved in a sufficient amount of sodium cyanide, and varying the excess of free sodium cyanide content of the bath, a series of current efficiency determinations were made in a Haring cell measuring 15 cm. between anode and cathode, and an immersed area of 5 times 5 cm. each. The temperature was between 22 to 24° C., and the current density was 2 amperes per sq. dm. or 18.5 amperes per sq. ft., throughout the series of determinations.

While the current efficiency determinations were made, which lasted 30 minutes of actual plating time, a set of readings were made at the end of 25 minutes for the bath voltage, temperature,

resistivity, anode and cathode polarization, with the aid of two screens of perforated copper spaced so as to divide the distance between anode and cathode into three equal parts. The perforations in those screens amounted to not less than 80% of the plane surface.

Taking up the variation of cathode efficiency first with respect to free cyanide content of a bath containing one mol copper, the relationship is essentially in a straight line, namely, cathode efficiency of such a bath with a carbonate content of approximately 43 grams of Na_2CO_3 per liter decreases directly with increase of free sodium cyanide from 95% at no free cyanide to 27% at 40 grams of free cyanide per liter.

This decrease of cathode efficiency with increase of free cyanide is in agreement with previous findings in cyanide copper plating baths of lower concentration. On the other hand, the anode efficiency of the same bath increases with free cyanide content. This increase is also in agreement with previous findings with the exception that the anode efficiency is higher even though there is 43 grams of carbonate per liter present. The exact figures obtained on anode and cathode efficiencies are given as follows:

Free Cyanide g/l By Analysis	Anode Efficiency	Cathode Efficiency
0.15	43.4	94.2
4.0	66.5	89.9
4.35	67.4	86.3
4.55	68.2	——
6.9	67.0	71.7
8.05	78.0	86.2
13.45	88.5	80.0
20.05	80.5	58.7
20.95	93.0	62.9
23.2	89.5	57.3
25.05	87.5	53.4
32.6	97.1	41.5
40.0	90.0	26.7
42.25	95.8	19.8

The resistivity of the electrolyte increases with increase of free cyanide content, which was to be expected. The increase, however, was not very great because the electrolyte has high conductivity to begin with. The variation is of between 8 ohms per cm. cube for zero free cyanide down to 7 ohms per cm. cube for a free cyanide content of 42 g/l.

Next, the effect of carbonate upon anode polarization was determined by a series of measurements in the Haring cell, using an electrolyte containing 12 ozs. of copper cyanide and 1.1 oz. of free sodium cyanide per gallon, it was found that anode polarization decreases rapidly with increase of carbonate content until a point is reached about 5.5 oz./gal. of Na_2CO_3, then it decreases slowly and increases again at about 12 ozs. of sodium cyanide per gallon. The tests ran as far as 21½ ozs. of Na_2CO_3 per gallon. Anode polarization increases also with anode current density. The increase is a rapid one, but the increase due to high current density is not as much when carbonate is 10 oz./gal. or over as when it is around 5 oz./gal. or less.

From the foregoing results it is possible to select a set of conditions regarding free cyanide and carbonate contents to the most desirable operating qualities of concentrated cyanide copper plating baths. For instance, we could aim at high current efficiency, and therefore choose a relatively low free cyanide content, such as 1 oz./gal. We could also choose a low anode polarization and therefore use a high carbonate concentration, such as 10 ozs. of Na_2CO_3 per gallon. Such a bath was prepared and tested again in the Haring cell, and the following data were obtained:

Copper Cyanide	12 oz./gal.
Free cyanide by analysis	1.1 oz./gal.
Sodium Carbonate	10.4 oz./gal.
Temperature	22 to 23° C.
Current Density	18.5 amps. per sq. ft.
Anode Current Efficiency	75.5%
Cathode Efficiency	95.0%
Voltage across Haring cell	4.6
Cathode Deposit	Smooth matte
Anode Appearance	Blue coloration, immediately soluble
Anode Polarization	1.55 volts
Cathode Polarization	0.85 volts
Bath Resistivity	7 ohms per cm. cube
Throwing Power (Blum-Haring method, distance ratio 5, (total current 1 ampere for a total cathode area of 0.5 square dm.)	47.4%

From these results it appears that there is a decided advantage of this concentrated copper solution in comparison with acid copper solution for practical applications of copper plating. For instance, since the acid copper solution has an efficiency of 98% to 99% and an electrochemical equivalent of 1.186 grams per ampere hour, and the concentrated cyanide copper bath has a cathode efficiency of 95% by the electro-chemical equivalent and double that of the acid copper bath, therefore the speed of cyanide copper plating at the same current density should be slightly less than double that of the acid copper bath.

As a matter of fact, the general practice for acid copper plating is to plate at not over 18.5 amperes per square foot. Therefore, if we assume that we operate either bath at 18.5 amperes per square foot, we could do copper plating almost twice as fast as the acid copper plating bath.

In addition, we have a much higher throwing power from the concentrated cyanide copper bath, because in the literature we found that the throwing power amounts to 9 to 10% according to the test made by Blum and Haring, using the similar apparatus and under comparable conditions.

Then we have the advantage when copper is directly deposited on steel, that there is no necessity for transferring from a cyanide copper bath to an acid copper bath, resulting in labor saving and time saving in the operation of copper plating. (Applause)

CHAIRMAN PHILLIPS: Mr. Lewis, are you prepared to answer any questions?

MR. LEWIS: I should not undertake to answer any questions, inasmuch as some of the findings are not in agreement with my own experience, and I think the discussion should take a very general form.

MR. GEORGE KUTZEN (Ford Motor Co., Detroit, Michigan): I have not very much to say, except that we differ somewhat with regard to free cyanide. We have two 7,000-gallon cyanide copper baths operated at a temperature of 110° to 120° F. Our metallic copper, at 8.23 ounces per gallon, is equivalent to copper cyanide in the amount of 11.59 ounces with free sodium cyanide of 5.39 ounces per gallon. That is on the radiator shells.

Metallic copper, 8.65, is equivalent to copper cyanide 12.19 and free sodium of 6.82. Carbonate will run from 3.2 to 5.6, never over. We have not been able to increase that as yet.

Our current density per square foot fluctuates between 22 and 30 amperes per square foot. Time of plating is twenty-eight minutes, and we have a thickness of coating of .0005" to .0006" on the shell.

The reason we have been using these heavy cyanide copper baths is that we went through the acid copper proposition pro and con. We found that, due to the poor throwing power and porous stock, we did not get the protection that we should get. We did not get proper coverage. We kept increasing our copper content an ounce or two ounces per gallon, until we reached fourteen or sixteen ounces per gallon. Our drop was quite heavy. Then we kept reducing it until we got down to ten ounces per gallon, and we found no trouble whatever with regard to blistering, providing the work was clean. When a man is working on anything pertaining to chrome, at any place where he touches any part of the work a blister will form, and there will be no uniformity of coating.

We have not been able to run less than four ounces of free cyanide. That has been our limit. As we run below that, our copper concentration drops and we have to add copper cyanide.

CHAIRMAN PHILLIPS: What do you find with regard to drag-out?

MR. KUTZEN: Your drag-out is heavy, but your loss is very low that way. If you eliminate the chromic acid factor it is just like rolling off a log.

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What Effect has the Shape of the Electro-plated Article on Throwing Power?

By Messrs. HAY and LOCKERBIE
Members Chicago Branch A.E.S.
Proprietors Standard Plating Works, Goshen, Indiana

WHAT is considered throwing power in a nickel solution? This also will apply to what is considered throwing power in a copper solution and, more so, to the fact that we always consider that a chromium solution has the poorest throwing power.

Now, if we had gone on and studied conditions as they really existed, we would have found out that there is no better throwing power in the nickel solution or in the copper solution than there is in a chromium solution.

The writer of this paper will attempt to show, with samples of plated parts and also with slides, the variations in the thickness of the deposit under certain conditions. Sometimes when engineers design an automobile for its beauty and attractiveness, to please the public, they do not realize what a burden they place not only on the manufacturer who has to manufacture those articles, such as radiator shells, but also on the plater, who has to electroplate such an article.

About a year or so ago the engineers of a certain large organization designed a car that, from all appearances, was very beautiful in design — especially the radiator shell. Little did they realize that the beautiful chrome plating furnished on this particular shell would not last over three months and, in some cases, not over one month. When production on this type of radiator shell was begun, the schedule was for 100 radiator shells a day, and, as conditions at the plating plant were such that sufficient time could be given to these shells, it was found that shells so plated would stand up in the salt spray test for any length of time, so no trouble was to be expected with regard to rust or service.

But behold, that was not so. As soon as these cars were out in service a very short time they would rust, and the manufacturer

had a merry time replacing radiator shells to keep his customers satisfied and contented. After an investigation we found very little plating, if any, down in the gutter or, as others call it, the "wishbone". I would like to ask the operator to show you that particular shell.

To our sorrow we found this to be a terrible job. The specifications demanded by that concern were for 125 grams of copper to that particular shell, and the shell represents twelve square feet. The nickel in that particular case is 60 grams per shell and that again represents twelve square feet.

When I talk about a "gutter" I want you gentlemen to have the picture of this shell in mind, so as to realize what we were up against when I talk about throwing power.

We sent this radiator shell all over the country to be plated and to be tested by large research laboratories, corporations that were absolutely outfitted to show whether we were wrong or right, and invariably they would find that this particular shell would always fail under any test that they would put it to.

After thoroughly checking the copper and nickel deposits microscopically for thickness, we found that the cyanide copper bath was acting very much like the nickel bath regarding the throwing power on this particular shell. We could not get any deposit down in the gutter, or wishbone, where we wanted it — at least, not the amount of metal that our specifications required. We tried out cyanide copper with high metal concentration, and vice versa, without success. We could not get metal where we actually needed it.

You may note the shape of this shell. Right down in the gutter, where water would stand under ordinary conditions, and where the plating should have been the heaviest, the plating was practically nil, and rust was the result. It was obvious, then, that there was some condition that existed that would cause a resistence in regard to electric current and would not allow the electric current to travel at an angle so as to deposit the metal as it should have been deposited.

We then drilled some holes in the neighborhood of this particular gutter so that the current could get through these holes, and we immediately noticed better results, but, as we could not drill any holes in these radiator shells, we had to find a way out of this difficulty. We prepared an auxiliary anode by using the well-

known porous cup and inserting metal, shaping it in the form of the gutter.

The result was very surprising, so we designed an auxiliary anode where copper could be used without any protection against short-circuiting in the plating bath. Our copper deposit was then very uniform and perfect all over. We could keep our copper deposit very smooth and uniform, and the deposit was actually 10.46 grams of copper in thirty minutes per square foot. I may mention the fact that when we did not have our auxiliary anode we tried to increase our throwing power in our cyanide copper bath by increasing the sodium carbonate. This immediately caused trouble, as the copper would be rough, pitted, and hard to buff, so we had to build a special anode to overcome that situation.

The following copper bath produced the best plating results:

Copper cyanide	31 grams per liter
Sodium cyanide	12 grams per liter
Sodium carbonate	13 grams per liter
Temperature	100° F.

By operating the copper bath with a special anode in the above plating solution, and the anode surface being three to one, we used a current density of 15 amperes per square foot very successfully, and obtained a very smooth copper deposit which was easy to buff. This also kept the metal content of the copper solution constant, and no addition of copper cyanide was necessary at any time; whereas, if the sodium carbonate is not controlled in the copper solution, constant addition of copper cyanide is necessary and rough deposit will result.

As this particular radiator shell has a surface of twelve square feet, and we plate twelve shells in the tank at one time, it was necessary to plate these shells for thirty minutes at fifteen amperes per square foot to obtain .0005″ copper or, in other words, 10.46 grams per square foot. As each one of these shells was weighed before and after our deposit and checked microscopically in the gutter as well as other parts of the shell, we had to show .0005″ of copper in the gutter after buffing. This simply meant that our copper deposit had to be heaviest in the gutter.

When production was very small these shells were plated in a nickel solution of a high pH with about four ounces of nickel chloride per gallon, and .95 to .97 nickel anodes were used, but due

to the shape of the shell and the vacuum and suction that were created when the shells were taken out of the nickel tank it was decided to cover the nickel anodes with canvas bags so that the roughness would be eliminated. However, while it did eliminate roughness, it created pitting, due to the fact that the solution would become unbalanced so quickly and constant additions had to be made to it. This was not only expensive, but it was also a waste of time, as production was constantly interrupted as the solution had to be filtered too often.

To make matters worse, we were not able to get a uniform nickel deposit, and our deposit in the gutter was very light and would not stand up in service. It was then decided to design an auxiliary anode in such a way that we would be able to get metal where it was actually needed.

These shells were plated in a horizontal position, and it was quite a trick to make special anodes so that they would adjust themselves to the shells in such a way that uniform spacing and distance would result. The first of these anodes was made of bakelite tubing with small holes drilled into them so that the metal could come through and deposit on the shell. The leads through the metal that was inserted through the tubes were made of lead wire. Whereas lead would constantly fail in the nickel solution, the nickel shots we were using would either not dissolve properly or else it would fall through the holes in the bakelite, so we decided to try something else.

Our next move was to take parts of scrap nickel anodes and insert them in a sheet of lead in such a way that the nickel anodes would face the sheet. The lead was then painted with a stop-off lacquer so that the nickel solution would not be active on the lead itself. The connections leading to the lead were made out of solid nickel anodes, and these leads were also kept painted with a stop-off paint, but due to the high carbon these anodes had to be covered with canvas, and the efficiency of the anodes would always break down in less than twenty-four hours. The canvas had to be replaced, and the anodes had to be washed and new canvas applied. As a result, the plating was so uncertain that we decided some other method had to be employed in order to get and maintain uniform results, as our customers by this time were very much worried, and everyone was up in the air.

At this stage we decided to use a nickel solution of low pH, and high metal content. The nickel anodes were replaced with a

99-plus carbon type and no bags were used. The auxiliary anodes were also made of 99-plus carbon type, and were not covered with canvas. The auxiliary anode holder was made of cypress wood, and the anodes were so plated that we felt a good, uniform deposit would result, but while we obtained enough nickel deposit as a whole, we did not gain our objective, due to the design of the anode holder. We would obtain too much nickel in one gutter and not enough in the other.

We then decided to make the nickel tanks deeper and plate the radiator shells in a vertical position, and again we made a mistake because we did not take the flow of the current into consideration. I will illustrate the design of the anode rack on the screen.

(*Slide*) You may notice the first auxiliary anode. That is the one that was covered with canvas and made out of solid nickel and inserted in the lead. The second anode that you see there was used while we plated the radiator shells in a horizontal position. This particular anode, which is not shown very clearly, was also used in a horizontal position.

The trouble with that type of construction was that we could not, on a production basis, hold it in a logical position. In other words, the distance might vary from three to four, and sometimes more, inches. We were not able to control the distance.

The other anode rack that you see here, which is the final result of what we were actually after, is a holder constructed out of cypress wood. These two pieces here are the guards against shorts. This particular part here, as you will notice, is actually the nickel anode. We found, with this type of construction, that we could absolutely control the distance in regard to the shell and the anode itself which in this case, was always four inches.

(*Slide*) This shows a cross-section of the top of the radiator shell in the wishbone, which rusted in service in less than thirty days. The deposit on top of that shell was .001, but in the bottom of the shell there was no deposit whatever.

(*Slide*) This shows the top of the shell plated in an acid copper solution; 800 ampere minutes were used in the copper and 400 ampere minutes in the nickel.

Now, while you noticed before that the shell actually showed a very heavy deposit, the wishbone actually does not show any deposit, and whatever you see here is nothing but rust, which finally proved that we were right in following our theory.

(*Slide*) This is the top of the shell, which withstood a salt spray test of forty-eight hours, and in this particular case you may notice that, while this is not a very good view, you have your copper here and your nickel following it.

While the shield that we used to protect the shell in this particular case, in order to obtain a heavier deposit, was somewhat successful, we did not gain our point.

(*Slide*) This shell was plated with the first type of auxiliary anode. This again will prove to you that the only thing you really see right now is nothing but rust and a very slight trace of nickel, but I still believe that there was nothing left but the chrome deposit.

(*Slide*) The other slide showed you the upper side of the wishbone, or gutter. This is the bottom of that particular wishbone. In other words, we have proved, then, that the anode was actually closer to that particular shell, and while the copper deposit was not very good, the nickel deposit actually showed some improvement.

(*Slide*) This is a view of the top of the shell under present conditions.

Now, we actually proved that our copper deposit would follow a straight line, and we also proved that our nickel deposit would follow a straight line, due to the fact that we could not consider throwing power, but we used mechanical ingenuity to overcome throwing power in a nickel and copper solution.

(*Slide*) The lower part of that particular anode did not perform its duty, due to the fact that the distance from that particular anode was so much greater than it was in the first place. The copper shows as a very slight line, and you might say that there was no copper deposit.

The next line is the nickel line, and in this particular case it may have just so happened that this shell was closer, or just about within the range of four inches; so, while we did not succeed in depositing copper, we did succeed in depositing nickel.

(*Slide*) This again shows you the opposite side of the same wishbone. I want to remind you of the fact that these solutions were absolutely controlled, and we always knew every hour in the day that we were correct so far as the condition of the copper and nickel solutions were concerned.

Now then, in this particular case you may notice again that you see the line of copper effect. The next line is the nickel effect.

In this particular case I say that the copper was less than .0001" and the nickel was practically .0003".

(*Slide*) I want to bring out one fact, that when we first designed this particular type of anode we made one mistake, and that was that our leads actually came in in this position, leading down here. The other lead came down here in a straight position. It may be surprising to everyone in the room to know that, while we could obtain .0008" of nickel deposit in twenty minutes in this position, we could obtain only .0002" of nickel in that position, so that is one of the reasons why I am questioning throwing power in the nickel solution.

In order to be absolutely positive that we were right and that everybody else was wrong, we had to convince ourselves that we could do the same thing every hour in the day. We had to invent a real means to be able to control this situation. We plated eight shells in that particular tank.

We wanted to be positive every day in every way that we were doing the right thing for our customers, so we did put this ammeter in that field and we could check, automatically, every minute, whether this or any other anode was inactive.

Then we found that if we inserted a new anode we would automatically have 65 amperes on that surface, and if another anode had been used for, say, several days (and no anode in this particular case lasted longer than four days), we automatically found that that particular shell would show 25 amperes, so we had to solve that problem. Automatically the buffer would come back and complain that the nickel was too hard to buff and, in some cases, that it showed pitting. It was decided that, in order to control that situation, we would insert a resistance in the field of every anode.

We proved that we could control that deposit and satisfy not only ourselves but the buffers and the engineering department by proving to them at all times that we were able to produce a nickel deposit of .0008" at any time. If we had not put in those resistances in some cases we would have had a nickel deposit which would have been too much and not satisfactory to us, because every ounce of nickel that is wasted is worth money, and the people to whom we furnish good plating do not desire to get a heavier deposit than .0008" of nickel on top of the copper.

(*Slide*) This is only the surface, right here, coming down to

the narrow line and down into the wishbone. That is actually supposed to be finished. Then you have all these other surfaces that it is not necessary to cover with nickel, so we designed what we called a shield, to cover this part of the surface in order to save money for ourselves and for our customers.

This completes my paper, but I want to make a few remarks on the papers that were presented on the copper cyanide solution. Mr. Woodmansee presented a paper on Copper Cyanide Plating. The way I feel about a copper cyanide solution is that there is no mystery in a copper cyanide solution—not any more than there is in any other solution. The only reason that we sometimes feel there might be a mystery is that we do not understand the copper or the nickel solution.

I made a statement that you would absolutely produce roughness by increasing sodium carbonate, and you will always produce roughness by increasing cyanide copper. There is only one thing that you can do, and that is this: You can increase copper in a copper cyanide solution by constantly adding sodium cyanide. You can control that increase of copper by controlling the addition of sodium cyanide.

Now, then, if we understand that and know what we are going about, I feel that another question enters in, and that is this: You take an electrolytic copper anode; you can increase your metal content in the copper cyanide solution too much, to your sorrow.

Take an electrolytic annealed copper anode and you may sometimes find that the job will not be as easy as you started out to do. The same thing is true of a nickel anode. For instance, if you have a nickel anode of low carbon type and try to do things as we have had to do them, then the next thing you have to do is to figure out how to cover that particular anode. And, by doing so, you are cheating yourself.

Well, what is the problem, then? The problem is to find out how to overcome that peculiar condition. There is one anode, as I have mentioned. You use 99-plus anodes. Some are of the sulphur type; some are of the carbon type.

Now, it is very strange that this particular carbon that is introduced into that anode acts as a screen. It does the very thing that these cloth or canvas bags will do, so let us be broad-minded about it and admit that the carbon type anode is the best to use.

Rust Proofing Before Color Finishing

By R. R. TANNER
Metal Finishing Research Corporation, Detroit, Mich.

Read at Detroit 1934 Convention

SINCE I am going to talk on "Rust Proofing Before Color Finishing", I am going to limit that to those processes that have to do with a phosphate coating, because they are recognized as being a good base for paint, and the time is rather limited, anyway, so I think I had better limit my talk to that particular thing.

The first thing we know of that was done in the phosphate processes was done by a man by the name of Ross, in 1869. He was a captain in the British Army, and he got interested in ladies' corset stays and somehow or other found out that they rusted. He found that by putting phosphoric acid on the stays he was able to inhibit the rust to some extent.

Nothing was done from that time until 1907, when Thomas Watts Coslett developed the Coslett process. That comprised a solution of dilute phosphoric acid that put a phosphate coating on iron and steel.

The next thing that was done was the Parker process. A man by the name of Richards (I forget the date) found that by adding manganese dioxide to this weak acid he could get better rust proofing.

The trouble with the Parker process was that it took too long. It takes an hour or two to complete the action, so it was important to develop a process that was quicker, so the next development was the Bonderize process. The way that worked was this: It was known that in order to get a coating on iron and steel it was first necessary to get the iron to dissolve and, if you increase the acid, you simply get a pickling acid that dissolves the coating. The coatings are soluble in acid, so the addition of a small amount of copper caused the iron to go into solution more rapidly.

The principal objection to the Bonderize process was that since you get the electrolytic action between the copper and the iron

that continues in case you get any moisture in there, and you get rusting rather rapidly afterward unless it is painted very quickly.

The next development was the Bonderize B and X processes. They used an entirely different principle to get acceleration. In the Parker process there is considerable hydrogen gas given off, and on account of this the solution is held away from the metal and does not get close contact, so the solution does not react rapidly enough and we simply added a depolarizer, such as nitrate, that would react with the hydrogen gas as long as it was formed, and thus give close contact at all times with the coating solution and the metal. That cut the time down from one to two hours in the Bonderize to about two minutes, and permitted a much smaller installation.

Then, another development along this same line is the Parkelite process, a spray process used for automobile bodies only. That can be sprayed on with a spray gun. It has inert material in it and the inert material is to hold the coating solution on the metal while it reacts, and then it is removed afterward. I will give you a very brief description of how each of the processes is carried out, because time is pretty limited.

For the Parker process the usual types of cleaning are used, such as sand blast, alkali cleaning with washing machine, or still tank, and, in some cases, a naphtha wipe. In case there is a lot of scale on the material to be processed it has to be pickled. The tanks used are either tumbling barrel type or still tanks, and the material that is Parkerized is usually bolts, nuts, screws, and things of that nature, although large transformers have been treated by that process and, after Parkerizing, usually stained and oiled.

The Bonderize process uses similar cleaning, such as alkali cleaning, washing machine, or naphtha wipe, and is usually followed by a wipe, either after cleaning or before. Sometimes they do it before they clean. The tanks used in that process vary from 100 gallons to 150,000 gallons, depending upon the amount of production. The largest tank I know of is about 150,000 gallons I have a picture of some of that installation, but I was unable to get a slide of all of it.

After Bonderizing, of course, the material is rinsed and then followed, after a water rinse, by a very weak chromic acid rinse, which gives a much better humidity test, and then the paint is applied.

(*Slide*) This is a typical still tank installation. There are several tanks in a row, sometimes carried on where conveyors are not used. The solution is maintained at the boiling point. The material is hung on a crane and dipped for two or five minutes, depending on the process being used.

(*Slide*) This happens to be the installation at the Hupmobile plant, another still tank installation. The material comes out of the washing machine, put on the conveyor, and pushed by hand over the Bonderize tank and let down there for two minutes.

(*Slide*) This shows a small conveyor installation. These are oil filters. They are wiped over here in naphtha, and after the cleaning operation they do gown through the installation in this way and out the other end.

(*Slide*) This is a picture of the Servel unit, on a little larger conveyor type, showing the refrigerator cabinets going through here. They go into the Bonderize tank at this point and go on through a drying oven over here. It is necessary to dry the coating after rinsing so that the unit can be plated right away.

(*Slide*) This shows the other end, after coming out of the drying oven.

(*Slide*) This shows one of the typical fender installations. It shows fenders on a conveyor entering the Bonderizing tank.

(*Slide*) This shows them coming out at the other end, where they are blown off with air.

(*Slide*) This shows another refrigerator installation, conveyor type. It happens to be of a company no longer in existence.

(*Slide*) This shows the inside of a Bonderizing tank. It gives an idea of the way they are heated. One method of heating is by steam coils along the side. That avoids stirring up any solution. The other type of heating is by steam jets. That has been done away with to a certain extent, or not entirely done away with, but we use side coils with it because it was found to be almost impossible not to get overflowing of the solution due to condensation of steam. It is very important to get a balance between the steam leaving the solution and the steam that is put in through the jets. That tank happens to be one of 70,000 gallons capacity.

(*Slide*) This shows the conveyor at the Ford Motor Company. They use a different type of conveyor because, in this case, the conveyors move sixty feet a minute, so they have to fasten the material so it will not fall off. This tank happens to be of 150,000 gallons capacity. It does not show all of the tank.

(*Slide*) This shows the other end, where they are blowing off with air.

The other process that I mentioned was the Parkeliting process. That is quite a little different. In that the material is sprayed on. In order to hold the coating material we have an inert material. We simply mix this powder in water until it is of good spraying consistency, and then it is sprayed on the body. It is necessary to clean the automobile bodies fairly well before spraying. Then the Parkelite is sprayed on, just as you spray lacquer. It goes through a drying oven for about twenty minutes at around 225° F., and then the inert material is either wiped off with brushes or washed off with water. There are two ways of doing that at present. Then the bodies are ready for painting.

(*Slide*) This shows them spraying the Parkelite on an automobile body.

(*Slide*) This looks rather rough, and it is. It shows the body after it has been through the drying oven, and the inert material is shown in the light spots. The places where it has fallen off are shown by the dark spaces. That comes off rapidly by putting it through automatic brushes.

(*Slide*) This is the way some installations work, by having automatic rotary brushes and a vacuum system to take the dust out.

(*Slide*) This shows the back view. Some installations, instead of using the brushes, have a fairly powerful water spray, and the body is cleaned with an alkali wash. That saves quite a little labor.

So much for the processes.

Now, you probably wonder why they use phosphate processes at all for paint. There are several advantages to a phosphate coating as a base for paint. The Parker process is not used very much for paint, because it takes too long and you do not need quite so much rust proofing. I forgot to mention that the Bonderize process is not as rust proof as the Parker, for the simple reason that we have a thinner and harder coating, so too much paint is not absorbed into the pores of the coating. It can be made more rust proof by the use of electricity and such methods as that, but we have found it not to be practical on a commercial scale, on account of the contamination of the contents, etcetera. We get along with a faster process and, if it is painted within a fairly reasonable time, it is sufficiently rust proof. In fact, one of the

companies is now sending fenders to England with a bare Bonderizing coating without paint until they get there, and they have very little rusting.

One thing that might be of interest from a Parkerizing standpoint of plate is that they have finishers now in which they take Parkerizing and tumble the parts in a mixture of aluminum dust and linseed oil, which puts an extremely thin coating on that looks like cadmium plating, and it can be handled very easily. It is a cheaper finish than cadmium, and we get better than two hours' salt spray by the addition of that aluminum dust.

All three coatings are important from a paint standpoint because they insure a very clean surface for painting. That is very important, and if you do have any grease or other material that will be detrimental to your paint, it usually leaves a bare spot in the Bonderizing coating which is visible to the eye and which can be cleaned before painting. Of course, it removes any small rust particles that might start reacting after paint is applied. Then, too, we get quite an increased adhesion of paint.

(*Slide*) This slide shows a photo-micrograph of a bare steel surface, and here is the same thing Bonderized. You have a crystalline surface and the paint is absorbed into the crystals while it is wet, and when it dries it cannot get off.

For that same reason, if we scratch a surface that is painted over Bonderize it will rust and scratch if you go through to the bare metal, but there is absolutely no spreading of rust from that scratch within a reasonable time.

Another thing we have been working on recently is that when you do get corrosion set up you always get a formation of alkali, and that is very bad for paint. I might show that on the board here. Just assume that you have a couple of panels hanging in a solution as a conductor connected by a wire. Now, if corrosion does take place and you get iron dissolving, going into solution as ferrous iron, then hydrogen is liberated at that point and, as your iron dissolves, you take two positive charges into solution with it, which leaves this particular electrode negatively charged. This, then, becomes positive, and then one of these hydroxile irons migrates to the other electrode.

We have some interesting results along that line. Of course, now, if you cut this wire so that there is no connection there, your current will not flow and you stop a lot of the alkali formation.

We found that a Bonderize coating does that thing. Take any panel that has a strain in it, and there are electropositive and electro-negative areas and you get that effect. Bonderizing is a fairly good insulator and stops a lot of that. We have succeeded in getting that alkali formation under the paint film, and it is rather interesting.

(*Slide*) This happens to be two dishes containing agaragar, in which we placed potassium ferricyanide and some phenolphthalein, which is a test for alkalinity. Both dishes contained the same jell. In this dish was placed a bare steel panel, and in the other a Bonderized panel. You can see the blue areas around the bare steel where the iron has started to corrode and is starting to dissolve. That is a very delicate test, of course. That shows where your iron is going into solution. That makes this area next to it positive, with the result that any hydroxile irons present travel to the positive one and are shown by the phenolphthalein indicator.

Now, in the case of the Bonderized panel, we get very little of that effect. There is a slight blue coloration that is not shown very well. We do not get corrosion, but we get an alkali formation.

This shows a similar instance. This is a section of two panels, one which was Bonderized and the other of which was not. The one on the right was Bonderized and finished with two coats of enamel, and this was not Bonderized. It was just the bare steel, and they had a small dot placed in the middle to go through to the bare metal. This rusted at this point but, as you see, it did not spread. This was in a salt spray some 200 hours. We usually find that seventy hours will show plenty of corrosion on bare steel with just the paint on it.

In this case there is no creeping of rust and your paint is very adherent to that particular area. In this case your rust shows where it has crept back, but the paint has peeled off over quite an area, due to the formation of this alkali. You have probably all seen that thing happen. It depends on the locality you are in. (Applause)

CHAIRMAN PHILLIPS: Is there any discussion of Mr. Tanner's paper, or are there any questions?

DELEGATE KOHLMEIER: I would like to ask if that works the same on cast iron as on sheet steel.

MR. TANNER: Just about, yes. It is a little harder to treat, however.

Exposure Tests
of Plated Coatings

On Non-Ferrous Metals Including Some Comparisons with Plating on Steel and Iron.

I. INTRODUCTION

At a conference in New York on September 26, 1934, plans for this investigation were discussed and numerous suggestions were made regarding the base metals and the coatings. These have been incorporated into the following schedule, which is now being distributed for further consideration. Changes may then be made in the light of the comments received, or of experience gained during the plating operations. A few blank spaces have been left for additional sets that may be included before the exposures start, or for supplementary tests. Suggestions regarding this program and recommended cycles for cleaning and plating each metal should be sent to W. Blum, Bureau of Standards, Washington, D. C.

II. GENERAL PLAN

All specimens will be 4 x 6 inches. The base metals will be obtained if possible in forms suitable for cleaning and plating, with at least one side uniformly polished. Suggestions regarding sources of such materials or offers to furnish or polish any particular base metals will be gladly received. It is expected that the required base metals, chemicals and anodes will be furnished without charge, as was done in the previous investigation.

All specimens will be plated at the Bureau of Standards under controlled conditions, so as to produce coatings of uniform quality and known thickness. They will all be exposed at the same time in six locations and inspected at intervals for corrosion or other evidences of failure. An additional number of each will be plated for use in accelerated and other laboratory tests.

The exact details of the cleaning and plating procedures will depend upon advice received and experience gained in preliminary tests. In general they will follow closely the methods used by us for plating on steel, with such modifications as are required for specific base metals. In general, the effects of the composition and thickness of deposits will be studied with one metal of

each group, such as brass, and only a few typical coatings will be applied to other alloys of that group.

III. SCOPE OF TESTS

The spaces for 112 sets will be used approximately as follows:

No. of Sets	*Base Metal*	*Form*	*Approx. Composition*
7	Steel	Rolled	Continue present tests.
6	Steel	Rolled	Repeat present tests.
4	Steel	Rolled	Same steel, new coatings.
2	Steel	Rolled	Different cold-rolled steel.
2	Steel	Hot-rolled	Spring steel.
2	Iron	Cast	Gray castings.
2	Iron	Cast	Malleable.
3	Copper	Deoxidized	Spinning copper.
6	Brass	Cast	High Brass A. S. T. M. B 65-28 #.
2	Brass	Cast	Ounce Metal A. S. T. M. B 62-28. 85 Cu, 5 Zn, 5 Sn, 5 Pb.
2	Brass	Extruded	Leaded brass. A. S. T. M. B 16-29. 62 Cu, 3 Pb, 35 Zn.
14	Brass	Rolled	High Brass. A. S. T. M. B 36-33. 66-69 Cu, Bal. Zn.
2	Brass	Rolled	Low brass. (B3-L). 85 Cu, 15 Zn.
5	Nickel-brass	Rolled	F. S. B., 65 Cu, 18 Ni, 17 Zn.
5	Nickel-brass	Cast	F. S. B., 65 Cu, 20 Ni, 4 Sn, 5 Pb, 6 Zn.
6	Zinc	Rolled	Pure Zinc.
6	Zinc-base	Die-casting	A. S. T. M. XXI. 93 Zn, 3 Cu, 4 Al.
26	Zinc-base	Die-casting	A. S. T. M. XXIII. 96 Zn, 4 Al.
10	Blank spaces		" — 63.5 Cu, 2.5 Pb, 34 Zn.
112			

IV. SCHEDULE OF DEPOSITS

1. Steel and Iron:

(a). (7 sets). Continuation of present exposures. A few specimens of typical sets that have not yet failed in a given location will be retained to determine their approximate life. The sets selected may be different in different locations.

(b). (6 sets). Repetition of Old Tests. These will be made on steel exactly like that used in 1931, as follows:

No.	*Description*	*Thickness[1], inch*		
		Copper	*Nickel[2]*	*Chromium*
S 1	Ni	...	100	...
S 101	Ni, Cr	...	100	2
S 110	Cu* (CN), Ni, Cr	50	50	2
S 113	Ni, Cu (A), Ni, Cr	30	20 50	2
S 106	Ni, Cr	...	200	2
S 116	Ni, Cu (A), Ni, Cr	60	40 100	2

* — Buffed.

[1] — To avoid confusion of decimal places, all thicknesses of deposits are expressed in hundred-thousandths of an inch.

[2] — All final nickel coatings will be buffed prior to chromium plating.

(c). (4 sets). **New Coatings on Steel.**

No.	*Description*	*Copper*	*Nickel*	*Chromium*	*Variable*
S 171	Ni, Cu (A), Ni, Cr	50	{ 20 / 30	2	Decrease final nickel (of 113).
S 172	Ni, Cr	..	100	5	Thickness Cr (101).
S 173	Ni, Cr	..	100	10	Thickness Cr (101).
S 174	Ni, Cr	..	200	10	Thickness Cr (106).

(d). (4 sets). **Different Steels.**

S 181	Ni, Cr	..	100	2	New cold rolled steel.
S 182	Ni, Cu (A), Ni, Cr	30	{ 20 / 50	2	" " " "
S 191	Ni, Cr	..	100	2	Spring steel.
S 192	Ni, Cu (A), Ni, Cr	30	{ 20 / 50	2	Spring steel

(e). (4 sets). **Cast Iron.**

I 1	Ni, Cr	..	100	2	Gray cast iron
I 2	Cu* (CN), Ni, Cr	50	50	2	" " "
I 3	Ni, Cr	..	100	2	Malleable cast iron.
I 4	Cu* (CN), Ni, Cr	50	50	2	Malleable cast iron.

2. Copper and Brass

(a). (3 sets). **Copper.**

C 1	Ni, Cr		20	2	Standard
C 2	Ni, Cr		50	2	Thickness Ni
C 3	Ni, Cr		50	2	Preparation

(b). (6 sets). **Cast High Brass.**

B 1	Ni, Cr	..	20	2	Standard
B 2	Ni, Cr	..	10	2	Thickness Ni
B 3	Ni, Cr	..	50	2	Thickness Ni
B 4	Ni, Cr	..	20	1	Thickness Cr
B 5	Cu* (A), Ni, Cr	20	30	2	Copper
B 6	Ni, Cr	..	20	2	Preparation

(c). (2 sets). **Cast Low Brass** (Ounce Metal).

B 11	Ni, Cr	..	20	2	Standard
B 12	Ni, Cr	..	10	2	Thickness Ni

(d). (2 sets). **Extruded Brass.**

B 21	Ni, Cr	..	20	2	Standard
B 22	Ni, Cr	..	10	2	Thickness Ni

(e). (14 sets). **Rolled High Brass.**

B 31	Ni, Cr	..	20	2	Standard
B 32	Ni, Cr	..	10	2	Thickness Ni
B 33	Ni, Cr	..	30	2	Thickness Ni
B 34	Ni, Cr	..	50	2	Thickness Ni
B 35	Ni, Cr	..	20	1	Thickness Cr
B 36	Ni, Cr	..	20	3	Thickness Cr
B 37	Ni, Cr	..	20	5	Thickness Cr
B 38	Ni	..	20	..	No Cr.

No.	*Description*	*Copper*	*Nickel*	*Chrom-ium*	*Variable*
B 39	Cr	..	...	10	No Ni
B 40	Cu* (CN), Ni, Cr	10	20	2	Cu (CN)
B 41	Cu* (A), Ni, Cr	10	20	2	Cu (acid)
B 42	Ni, Cr	..	20	2	Preparation
B 43	Ni, Cr	..	20	2	Preparation
B 44	Ni, Cr	..	20	2	Preparation
(f).	(2 sets). **Rolled Low Brass.**				
B 51	Ni, Cr	..	20	2	Standard
B 52	Ni, Cr	..	10	2	Thickness Ni
(g).	(5 sets). **Rolled Nickel Brass.**				
N 1	Cr		..	20	Standard
N 2	Cr		..	10	Thickness Cr
N 3	Cr		..	5	Thickness Cr
N 4	Ni, Cr		10	10	Thickness Ni & Cr
N 5	Ni, Cr		20	2	Thickness Ni & Cr
(h).	(5 sets). **Cast Nickel Brass.**				
N 11	Cr		..	20	Standard
N 12	Cr		..	10	Thickness Cr
N 13	Cr		..	5	Thickness Cr
N 14	Ni, Cr		10	10	Thickness Ni & Cr
N 15	Ni, Cr		20	2	Thickness Ni & Cr

3. Zinc and Zinc Base-Die Castings:

H.S.—high sulphate, C—citrate, S—standard.

(a).	(6 sets). **Sheet Zinc.**				
Z 1	Ni (H.S.), Cr	..	50	2	Standard
Z 2	Ni (H.S.), Cr	..	20	2	Thickness Ni
Z 3	Ni (H.S.), Cr.	..	50	1	Thickness Cr
Z 4	Ni (H.S.), Cr	..	50	3	Thickness Cr
Z 5	Ni (H.S.), Ni (S), Cr	..	20 / 30	2	Duplex Ni
Z 6	Cu (CN)*, Ni (S), Cr	20	30	2	Copper layer
(b).	(6 sets). **Die-Castings, A. S. T. M. XXI.**				
Z 11	Ni (H.S), Cr	..	50	2	Standard
Z 12	Ni (H.S.), Ni (S), Cr	..	20 / 30	2	Duplex Ni
Z 13	Ni (H.S.), Ni (S), Cr	..	20 / 80	2	Duplex Ni
Z 14	Cu (CN)*, Ni (S), Cr	20	30	2	Copper layer
Z 15	Cu (CN)*, Ni (S), Cr	20	80	2	Copper layer
Z 16	Cr	..	..	20	Direct Cr
(c).	(26 sets). **Die Castings, A. S. T. M. XXIII.**				
Z 21	Ni (H.S.)	..	50	..	Standard Ni
Z 22	Ni (H.S.)	..	20	..	Thickness Ni
Z 23	Ni (H.S.), Cr	..	50	2	Standard Ni, Cr
Z 24	Ni (H.S.), Cr	..	20	2	Thickness Ni
Z 25	Ni (H.S.), Cr	..	50	1	Thickness Cr
Z 26	Ni (H.S.), Cr	..	50	3	Thickness Cr
Z 27	Ni (H.S.), Cr	..	50	2	Preparation

No.	*Description*	*Copper*	*Nickel*	*Chromium*	*Variable*
Z 28	Ni (H.S.), Cr	..	50	2	Acid dip
Z 29	Ni (C), Cr	..	20	2	Citrate Ni
Z 30	Ni (C), Cr	..	50	2	Citrate Ni
Z 31	Cr	..	..	20	Direct Cr, hot
Z 32	Cr	..	..	50	Direct Cr, hot
Z 33	Cr	..	..	20	Direct Cr, cold
Z 34	Cr	..	..	50	Direct Cr, cold
Z 35	Ni (H.S.), Ni (S), Cr	..	20 30	2	Duplex Ni
Z 36	Ni (H.S), Ni (S), Cr	..	20 30	1	Thickness Cr
Z 37	Ni (H.S), Ni (S), Cr	..	20 80	2	Thickness Ni
Z 38	Ni (H.S.), Ni (S), Cr	..	20 180	2	Thickness Ni
Z 39	Ni (H.S), Ni (S), Cr	..	20 30	2	Preparation
Z 40	Cu* (CN), Ni (S), Cr	20	30	2	Initial copper layer
Z 41	Cu* (CN), Ni (S), Cr	30	70	2	Thickness Cu, Ni
Z 42	Cu* (CN), Ni (S), Cr	50	150	2	Thickness Cu, Ni
Z 43	Cu* (CN), Ni (S), Cr	30	20	2	Ratio Cu/Ni
Z 44	Ni (H.S.), Cu (CN)*, Ni, (S), Cr	20	10 20	2	Inter. Copper layer
Z 45	Ni (H.S.), Cu (CN)*, Ni, (S), Cr	30	20 50	2	Thickness
Z 46	Ni (H.S.), Cu (CN)*, Ni, (S), Cr	80	20 100	2	Thickness

CHICAGO BRANCH A. E. S.

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Hotel LaSalle

Saturday, January 19, 1935

Tickets $2.50 — include the Educational Meeting from 2.30 p. m. to 4.30 p. m.; Banquet-Dance and Entertainment from 7 p. m. to 11.30 p. m. Tickets may be had *now* from the Secretary, J. W. Hanlon, 3004 N. Whipple St., Chicago, Ill.

A Hearty Welcome to You

A Morro Castle Disaster

Every Other Day

From The Travelers Standard

Year	Deaths in marine disasters throughout the world	Motor-vehicle deaths in the United States alone
1933	97*	29,900
1932	340	29,000
1931	945	34,400
1930	383	33,300
1929	859	31,215
Total	2,624	157,815
Yearly average	525	31,563

*Includes 70 lives lost when the United States navy dirigible balloon *Akron* was struck by lightning.

WITH no intention of belittling the importance of the disaster in which the *Morro Castle* was involved, early in the morning of September 8, it seems wholly appropriate to remark that the net result in loss of human life in that tragic event was less than the total number of deaths that occur on our streets and highways *every other day*.

According to the records, more than 130 persons were burned to death, or drowned or killed in some other way, in consequence of the fire on the *Morro Castle*. Every two days, on the average, throughout the year 1933, 166 persons—motorists and pedestrians—were killed in motor-vehicle accidents. The statistics to date, for 1934, indicate an even higher fatality rate which will equal or perhaps exceed the all-time high record of 1931—a record of 94 deaths each day, on the average. Each autumn Sunday recorded approximately 130 fatalities.

The ordinary person acquires a large part of his information from the newspapers. This does not necessarily mean that such information is complete, however, and because all the facts are not known it often happens that incorrect conclusions are formed. For example, there is a more or less general belief that traveling by ship is excessively dangerous, as compared with other methods of transportation, and every marine disaster seems to bear out this opinion. As a matter of fact, the loss of life resulting from boat travel is insignificant as compared with the number of fatalities arising from automobile accidents. Of course, far more persons travel by automobile than by water-craft and consequently, in a given time, more deaths are to be expected from motor-vehicle accidents than from shipwrecks and other

marine disasters. Disregarding the "exposure" element, however, it will be interesting to compare the actual loss of life resulting from the two kinds of travel over a period of years.

FATALITIES FROM MARINE DISASTERS AND MOTOR-VEHICLE ACCIDENTS

The World Almanac for 1934 gives a list of "Notable Marine Disasters in 100 Years," including, in most cases, the number of fatalities. There were 448 of these disasters which occurred all over the world. The causes of the catastrophes were many—gales, fogs, hidden rocks, collisions with icebergs and other vessels, boiler and other explosions, and fires. Vessels that left port and were never heard from again are included in the list, as well as those sunk by mines, torpedoes, and submarines during the World War. The total loss of life—passengers and members of the crews of the vessels—was 76,373. Remember, this is the death toll of all important marine disasters *throughout the world* during the *one hundred years* 1833-1933—a yearly average of 764.

Contrast this with the number of deaths *in the United States* alone, resulting from motor-vehicle accidents, as shown in the accompanying table. It will be seen that the loss of life from automobile accidents during the last three years exceeded the number of fatalities (76,373) in marine disasters during the last 100 years, and that during the last five years motor-vehicle deaths were more than twice as many as the 100-year total of fatalities from shipping disasters.

A steamship disaster arouses general interest because hundreds of human lives are endangered (and perhaps lost) at one time and in a particular locality. An automobile accident of similar magnitude (if this were possible) probably would create an equal amount of comment and attention—this is indicated, in fact, by the publicity given to a bus accident which occurred last July and resulted in the death of nineteen persons. The average automobile accident seldom involves more than half a dozen persons, however. It happens almost instantaneously and hardly ever is there opportunity for heroic attempts to save life or for the other dramatic accompaniments of marine disasters. Nevertheless, these "average" accidents, occurring all over the country, brought about a fatality rate of *more than* 80 *persons a day*, in 1933.

It is hard to understand the apparently complacent attitude of people in general with regard to motor-vehicle casualties.

Nearly every person that has not been directly involved in an accident as a victim or a spectator, at least has a relative, friend, or acquaintance who has had an unfortunate personal experience of that kind. Daily newspaper accounts of local and distant accidents tend to indicate that the danger is universal.

It is generally known that manufacturers are constantly striving to build safer cars; that wider, straighter, and smoother highways are being constructed; that warning signs and signals are being placed at danger points; and that laws and ordinances are being enacted to promote safer driving. But those who are almost wholly responsible for accidents—the operators of automobiles—and who by their own efforts could reduce the accident toll nearly to the vanishing point, seem to remain indifferent to the danger that constantly menaces them, their families and friends, and the public in general.

In the early days of motoring, the automobile was considered an unnecessary adjunct to the methods of transportation then in use, and an altogether dangerous contraption. It is doubtful if anybody at that time even imagined that in a few years it would become not only a practically indispensable business and pleasure vehicle but also the most important agent of personal injury and death that has ever been devised for common use. We cannot believe that this hazard will be allowed to exist indefinitely. If motorists will not acknowledge and correct their own errors, public opinion will demand that their driving privileges be curtailed sufficiently to assure reasonable safety to life on the highways—and public opinion is irresistible.

Modern well-maintained cars and present-day improved highways with suitable warning signs at danger points, supply nearly all the protection needed against the physical hazards of motoring, and the existing legal restrictions and regulations would be almost wholly adequate for safety—if they were observed. It is the improper mental attitude of motorists, manifested by careless and reckless acts and behavior, that is chiefly responsible for "a *Morro Castle* disaster every other day" on the highways.

Promote safe driving. Get in the Membership Drive—it's safe and sane.

The Abstract Section

T. F. SLATTERY, *Chairman, Program and Educational Committee*

As explained in the November REVIEW, an effort will be made to prepare especially for electroplaters, original abstracts of the more important articles published in this field. Some of the foreign journals that contain papers on electroplating are rather inaccessible, with at most very few copies in this country. Efforts are being made by the editor to secure such journals by exchange or purchase.

In the meantime, to avoid delay, a few such abstracts will be copied or adapted (with permission) from those in Chemical Abstracts (*C. A.*) or in Metals and Alloys (*M. A.*) in each case with appropriate acknowledgment. Where necessary the customary American units for temperature, concentration and current density will be included in these abstracts.

Standardizing Nickel Plating Baths. V. M. GUSKOV and A. Z. RIVKIND, *Metallurg.* (Russian) **9** No. 1, 69-85 (1934).—Best results in plating can be obtained by using $\underline{N}$ and $2\underline{N}$ solutions of nickel sulphate (19 oz/gal and 38 oz/gal of $NiSO4.7H_2O$) with current densities of 47 and 65 amp/ft^2 respectively. As anode depolarizer, chloride of sodium, magnesium, or nickel may be added in concentrations of 0.05 to $0.2\underline{N}$. (The $0.2\underline{N}$ corresponds to 1/6 oz/gal NaCl, 2.7 oz/gal $MgCl_2.6H_2O$, or 3.2 oz/gal $NiCl_2.6H_2O$). From 1.5 to 3.5 oz/gal of boric acid may also be added. For fast work a temperature of 104° to 122°F with a current density of 93 amp/ft^2 is recommended.

C .A. **28,** 6067, 1934. H. W. RATHMANN.

Importance of pH in Nickel Plating. M. BALLAY. *Usine* (French) **43,** No. 29, 37 (1934).—Nickel deposits from standard baths with pH between 7 and 9 were not satisfactory, owing to formation of hydroxide or basic salts. Presence of boric acid causes a premature hydroxide precipitation, while ammonium and sodium salts retard precipitation. Good deposits are obtained as long as precipitation of hydroxides or basic salts is prevented, even in a range of pH from 3.5 to 10, with current densities up to 93 amp/ft^2. Addition of citric acid (also glycolic and lactic acid) prevents precipitation. Deposits can be

obtained at 104°F with current densities from 19 to 93 amp/ft^2 and with pH from 3.6 to 9.8 in a solution containing 2.8 oz/gal of nickel, 0.9 oz/gal of NH_4 (equivalent to 2.7 oz/gal of ammonium chloride) and 20 oz/gal of sodium citrate. With a cathode current density of 20 amp/ft^2, the cathode efficiency was 59.2% for pH 5, 90% for pH7 and 94.2% for pH 9.6. The anode efficiency under the same conditions was close to 100% for pH 5 to 7, but only 88% for pH 9.6.

C. A. **28,** 6067; 1934. M. HARTENHEIM

Nickel Plating of Aluminum. M. BALLAY. *Rev. Aluminum* (French). **11,** 2365 (1934).—After degreasing with organic solvents, the oxide film is best removed by pickling in hot ferric chloride (made by diluting to one liter, 50 cc of an aqueous solution of ferric chloride with sp.g. of 1.42 and 50 cc of concentrated hydrochloric acid with sp.g. of 1.18.) The nickel plating bath may contain 17 oz/gal of nickel sulphate, 3 oz/gal ammonium sulphate, 4 oz/gal sodium sulphate, 4 oz/gal magnesium sulphate and 0.7 oz/gal sodium chloride. This bath is used at a pH of 5.5 to 6.5, a temperature of 95 to 113°F and a current density of 20 to 40 amp/ft^2. For rapid plating the solution contains 55 oz/gal of nickel sulphate, 3 oz/gal nickel chloride, and 3 oz./gal boric acid, with a little nickel nitrate to prevent pitting. The latter bath is operated at a pH of 5.3 to 5.7, a temperature of 113° to 122°F and a current density of 30 to 95 amp/ft^2. Nickel-plated aluminum can be readily soldered with tin to give strong joints. *C. A.* **28,** 6639, 1934. B. C. A.

Manufacture of Sheets of Electrolytic Copper. M. ALTMEYER. *Cuivre et laiton* (French) **1,** 367, 1934.—Large sheets of pure copper are made by electrolytically depositing copper on rotating cathodes of cast iron or steel, 13 ft. long and 27 in. in diameter (7 ft. in circumference). The tubes thus produced, if not used as such, are cut open, straightened and annealed. The current density is 40 amp/ft^2, and the cathodes rotate at 30 to 40 r. p. m. In order to facilitate removal of the deposited sheet from the cathode, the latter is coated with a special lacquer. The cathodes (contrary to other similar processess) are fully submerged in the electrolyte, which is actively stirred during the process. The copper as deposited has a tensile strength of 40,000 lb/in^2 and elongation of 34%; after annealing these figures are 30,000 lb/in^2 and 50%. Sheets are made from 0.005 to 0.017 in. and also of greater thickness. The equipment

of the plant, which is laid out for 60 to 90 tons per month, is described. *C. A.* **28,** 6639, 1934 M. H.

Preparation of Silver Baths by Anodic Solution of Fine Silver. K. W. FROELICH. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle.* **8,** 15, 1934 (May-June). A simple method to prepare baths for silver plating is described. Instead of dissolving the silver in nitric acid, precipitating as silver chloride and dissolving in aqueous potassium cyanide solution, cast anodes of fine silver are suspended in the cyanide bath. Copper or silver strips surrounded by a porous porcelain cell serve as cathodes. By weighing the anode before and after a certain time, the silver content of the bath can be determined and adjusted accordingly. This method requires very little attention; as the current efficiency is about 70%, the current only need be observed, because 1 ampere/hour dissolves about 3 gram (0.1 troy oz.) of silver. This determines directly the time needed to introduce the required amount of silver into the bath. Several anodes can be used provided they are not spaced too close together or near the wall. Heating the bath above 104°F must be avoided, as otherwise the cyanide decomposes easily.

M. A. **5,** 526, 1934 H. A.

Printed Matter for Nickel Articles. Memorandum No. 7, Printing Industry Research Assoc., Oct. 1934.—When certain labels that were printed with black ink on glassine (transparent) paper were attached by a gum to nickel plated articles, the surface of the latter became "fogged" with a dull, creamy film, except where the black letters were present. An investigation showed that this tarnish of the nickel was caused by the presence in the paper of sulphur dioxide and sulphates. It is recommended that paper for such purposes should be as free from sulphur dioxide, sulphate and acidity as possible. The fogging effect of a contaminated paper may be prevented by applying a very thin film of lanolin to the nickel surface before attaching the label. (In his study of the crystal spotting of sulphide finishes, W. P. Barrows found that a very thin film of grease on the metal surface prevented sulphur present in the wrapping paper from reaching the metal. Abstractor). W. BLUM.

Improved Methods of Chrome Plating. J. GESCHELIN. Automotive Ind. **71,** 134, (1934).—The various methods used for plating zinc-base die castings are reviewed. The present practice for the plating prior to the chromium layer is summarized

as follows: (1) minimum thickness of nickel should be 0.0003 in. (2) Any copper layer should be a heavy coating. (3) With multiple coats, the final nickel layer should be 0.0003 in. (4) Specifications should be based on outdoor exposure tests.

W. BLUM.

The Deposition of Chromium from Aqueous Chromic Acid Baths Containing the Fluoride Iron. By ERICH MÜLLER and H. DRECHSEL. *Zeitzschrift für Elektrochemie* — Vol. 40 - No. 10 1934, pages - 707-713. — In previously published works it has been reported that the substitution of sulfate by fluoride in chromium solutions results in better throwing power and makes possible the production of bright plates form cold solutions. The results of more extensive work on this subject is reported in this paper.

The cell recommended by Haring and Blum was used for throwing power determinations. The far cathode was maintained at twice the distance from the anode as the near cathode. In order to express the throwing power "T" (Tiefenwirkung) quantitatively, the following relation was used:-

$$T\% = \frac{2 - X}{2} .100$$

$$X = \frac{\text{wt. chrome on near cathode}}{\text{wt. chrome on far cathode}}$$

With this relationship when the value of X is 2 (inverse relation of cathode distances from anode) the T value is zero. The conclusions reached after many series of runs with various conditions are:

1. The cathode efficiency is much less dependent on temperature with the fluoride bath than with the sulfate bath. The fluoride bath operated either at 23°C. or 40°C. has a higher efficiency than the sulfate at 40°C.

2. With fluoride, the bright plate range in respect to temperature, is much less critical than with sulfate. At 23°C. bright plates were obtained from 3 g/l of K F .$2H_2$ 0 to 13 g/l while with sulfate no bright plate is obtained as 23°C. and the range at 40°C is from .76 g/l to 4.8 g/l.

3. With equi-molar quantities the throwing power of the fluoride baths is greater than the sulfate for all concentrations.

4. At 40°C, the cathode efficiency of the fluoride bath is higher with increasing current density than is the sulfate bath.

5. When sulfate is present the effect of adding fluoride is almost negligible. Mixed baths are not recommended.

Fluoride baths have been used very successfully in commercial practice and this abstractor would advise their use especially where temperature control facilities are not available. W. R. MEYER

BOOK REVIEW

PRINCIPLES OF ELECTROPLATING

(*Prinzipien der Galvanotechnik*).

By Jean Billiter

326 Pages, 86 illustrations. Julius Springer, Vienna.

Again it seems justifiable to include in the REVIEW a reference to a book on electroplating that is printed in German. Every plater who can read German, and every chemist engaged in research or testing in the electroplating field will find this book very valuable. The author not only includes references to practically every recently published research in this field, but he also summarizes the results critically, and points out the need for further research on many subjects.

The most valuable part of the book is the discussion of the structure of electrodeposits, illustrated by well chosen and well printed photographs, and including some previously unpublished experiments of the author and his associates.

W. BLUM.

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Please mention THE MONTHLY REVIEW *when writing*

BOSTON BRANCH

Boston Branch met Thursday, November 1st, at the American House with Past President Gale in the chair. After the regular order of business the meeting was open for the general discussion of the "Plating of Die Castings." Most all the members got into the discussion and told of their experiences in the plating of die castings. Mr. Franklin gave his experience and said that he had been having very good luck with his work and showed five different samples that were plated in nickel and then in the chrome and they were very good. He explained how he does the work and also gave the formula for the solution that he is using. A vote of thanks was given to Mr. Franklin for his part in making the meeting one of the best that the Branch has had in a long time.

One application was received for membership and was elected to membership.

The meeting adjourned at 10:30 P.M. A. W. GARRETT, *Secy.*

ST. LOUIS BRANCH

Regular meeting of St. Louis Branch was held Friday November 2, 1934. As we had a chance to see a motion picture shown at our meeting, the meeting was moved up one week.

The picture was educational and very interesting. Lasted about an hour and 15 minutes, after which our meeting was held. Roll call of officers showed one absent. Our president, who has been operated on, has left the hospital and is now resting at home. We wish him a speedy recovery.

It was decided to have our next meeting at the Central Y. M. C. A., and serve a dinner. A vote of thanks was given Mr. H. J. Richards, for arranging the picture at our meeting.

It was with sorrow that we learned of the death of Mrs. Daw, mother of Mr. B. Daw of St. Louis Branch. The St. Louis Branch members extend their heartfelt sympathy.

One application was received, which will be acted on at our next meeting.

CHAS. T. MCGINLEY, *Secretary.*

ROCHESTER BRANCH

On Friday night, October 19, the Rochester Branch held its regular monthly meeting at the Seneca Hotel. In the absence of President Kohlmeier the meeting was called to order by Vice-President Chas. Hehr. The minutes of previous meeting were read and approved as read. After regular routine business the Secretary read a few excerpts from the article on "Bright Nickel Plating" as presented by Mr. L. E. Eckelmann at the annual convention, and a general discussion on the merits of this particular type of plating then took place.

JUDSON R. ELSTER, *Sec'y.*

DETROIT BRANCH

A regular meeting of the Detroit Branch was held on Friday evening, November 2nd, at the Hotel Statler, at 8:00 P.M.

Col. Hansjosten presided. There was a good attendance. Minutes of the previous meeting were read and approved. Applications for membership were received as follows: Floyd Julian Waugh, 14346 Ardmore Ave. This application was referred to the

Board of Managers for investigation and report.

Mr. Leon Moore, Almont, Michigan, was reinstated as an active member.

The following seven were reported on by Board of Managers favorably and unanimously elected to membership:

Ray A. Austin (Active)
1483 Montclair Ave., Detroit, Mich.
Govie W. Collins (Active)
1745 Baldwin Street, Detroit, Mich.
Robert L. Reed (Active)
2567 Parker Ave., Detroit, Mich.
Delos R. May (Associate)
2700 Wight Street, Detroit, Mich.
Jacks D. Clayton (Associate)
2842 W. Grand Blvd., Detroit. Mich.
Leo W. Paul (Active)
3286 E. Fort Street, Detroit, Mich.
Lawrence W. Rowley (Active)
6320 E. Fort Street, Detroit, Mich.

Correspondence and bills were taken up by the Board of Managers before the meeting and passed on, as well as the financial report.

Mr. Soderburg extended an invitation to the Society to attend a meeting of the American Electro-Chemical Society to be held November 13th at the Woman's City Club. There will be a dinner at 7:30, which will cost $1.00. The meeting will begin at 8:45 P.M., which is free. Everyone is invited to attend both. There will be a wonderful paper and discussion by Mr. Happsteel of the American Telephone & Telegraph Co.

The speaker of the evening, Mr. Tuttle of the Tuttle Chemical Co. was then introduced by Col. Hansjosten. He presented a talk rather than a paper on the merits of Zialite which is a prepared solution for nickel-plating zinc and zinc bar die castings. There was quite a bit of discussion, which was interesting as well as instructive. Mr. Tuttle has promised to give the Secretary a paper covering his talk so he can send it to the REVIEW for publication later on.

The Question Box was then conducted by Mr. B. F. Lewis, Acting Librarian. It would seem that the Question Box is not as well taken as it should be as there was but one question regarding plating, which was as follows: *Suggest an etch for zinc die castings before copper plating.* Answer: Acid dip weak enough that only slight evolution of gas. Use hydrofluoric, hydrochloric, or sulphuric acid.

The Membership and Educational Committees will jointly take charge of the program and refreshments at our next meeting, December 7th. The speaker of the evening will be W. W. Phillips, of the General Motors Corporation, who is Chairman of the Research Dept. of the American Electro-Platers' Society, and he will have interesting illustrations on the subject of actual electroplating, in the form of motion-pictures.

The meeting adjourned at 10:30 P.M.

T. C. EICHSTAEDT,
Secretary-Treasurer

MILWAUKEE BRANCH

The regular meeting of Milwaukee Branch was held at Lipp's Hall, Thursday evening, November 8, 1934. The meeting was called to order by Vice-President Dexter Rhodes. After a short business meeting, Assistant Librarian Al. Hermansen read a paper entitled "Improved Methods of Chromium Plating." by Joseph Geschelin, Engineering Editor *Automotive Industries.* This paper was discussed pro and con by the members, some stating that while such specifications were rigid, there was still too much of the personal element in inspection, between vendor and vendee.

Mr. Wm. Brandt showed us a rather novel chromium plating rack, with which he did some good plating. It

is a positive contact wire, or hook, about the shape of half a small barrel hoop.

Ques. How is a bath for anodic treatment of aluminum operated?

Ans. Very little known about it here, but at a future meeting some recent information will be available.

Ques. Can chromium be barrel plated?

Ans. Not practical at this time.

Ques. What causes cast brass shower heads to peel?

Ans. Discussed at length and decided that perhaps another type of cleaner would help, also try copper plate and buff before nickel plating.

Jacob Hay of Chicago was present at our meeting, and is going to favor us with his paper, "What effect has the shape of an article on throwing power." Jacob Hay will present this at our December 13, 1934 meeting. We hope to have a large gathering at our December meeting. FRANK J. MARX,

Secretary-Treasurer.

CHICAGO BRANCH

The regular monthly meeting of Chicago Branch was held November 10 at the Atlantic Hotel, President E.G. Stenberg presiding and all other officers present.

The application of Mr. P. Borghetti read and committee appointed. Mr. R. Bruske and Mr. A. Raml were elected to active membership.

Mr. F. J. Hanlon, Chairman of the Banquet Committee reported on the progress being made for holding our Twenty-Third Annual Banquet on January 19, 1935, at the LaSalle Hotel.

Mr. C. Stiers who has been very ill is now on the road to recovery and we all hope to see him out and around within a short time.

The Librarian found the following questions in the question box:

No. 1. Is there a Rheostat made where one can obtain a definite amperage per square ft. and maintain same and then vary voltage without changing the amperage?

Ans. It can be done, but it is not very practical unless all factors are known and then a special rheostat could be built for same.

No. 2. Is it possible to put a jet black finish directly on steel by means of a chemical dip, if so, how is it done?

Ans. Yes. By the Parkerizing Method.

No. 3. Is there any advantage to buff the chromium plate or leave it unbuffed?

Ans. Buffing helps prolong the life of the plate due to the slight film from the buffing compound.

No. 4. What oils can be used on Chrome solutions to reduce spray losses and aid the ventilating system? Will such oil cause trouble in operation of the Chrome tanks?

Ans. Fish oil or Kerosene. But are not very practical on production work and are not recommended.

No. 5. What effect does iron and chlorides have in the cleaning tank?

Ans. If the chlorides get high enough they eat a hole in the tank.

No. 6. What is considered an excess of carbonate in a copper solution?

Ans. 12 to 15 oz. of carbonate, to lower same add about 10 pds. of slacked lime to 100 gals. stir and allow to settle then filter off clear solution, and clean out the sludge. Then add about ½ gal. sulphuric acid per gal. Caution — before adding acid see that this is done under a good suction fan to carry off the fumes.

No. 7. Is it general practice to enamel directly after a degreasing operation?

Ans. Yes, providing no buffing compounds have got into the degreasing solutions.

No. 8. What method is best for securing good contacts for very light material, spring contacts with rubber cov-

ered hooks except where contact is made, or just plain hooks with work hung on? (This is for a full automatic equipment.)

Ans. Several firms make special rubber covered racks that are O. K. for this type of work.

No. 9. What is wrong with a nickel deposit that cannot be welded. That is the weld breaks?

Ans. May not be cleaned right or too heavy a deposit of nickel will cause weld to break away.

No. 10. What is a good brightener for a nickel solution, and how will the brightener effect the solution?

Ans. A small amount of cadmium is used for a brightener. pH must be controlled.

No. 11. Like to know a good lubricant for use in ball burnishing of steel work.

Ans. 50 gal. water, 30 pds. soap flakes, 12 lbs. soda ash, and a small amount of cyanide.

No. 12. Is an artificial abrasive better for polishing than natural emery?

Ans. Artificial abrasive cuts faster. Natural emery gives and is used for higher finishes. Each has its place.

Mr. H. Faint at the request of Mr. O. E. Servis read the June report and tentative specifications by the Research Committee which proved to be of great interest to all members.

J. W. HANLON, *Sec'y.*

WATERBURY BRANCH

The November meeting of Waterbury Branch A. E. S. was held Friday evening, November 9, in Engineers Hall President Tennant Elwin presiding. A good attendance was present, and much interest was manifested in the talk of Ellsworth Candee, who gave an account of the recent electroplating conference held in New York City. The speaker outlined the objects sought and the methods to be adopted in accomplishing same. Touched on the keen interest being displayed by some of the large manufacturing concerns of the country in sending representatives to the conference. Mr. Candee went into details on the grades of plating and the recommendations made in the specifications for plating nickel and chromium on steel. Told of the campaign of the Research Committee to raise the sum of $5000.00 per year for two years to pay the costs of the research work. At the conclusion of his talk, the speaker answered many questions in connection with same, after which he was extended a vote of thanks. Richard Crane of the local branch also contributed some interesting information concerning plating matters in the West. The next meeting of the Branch takes place Friday evening, December 14, and the committee in charge, promises an exceptionally interesting meeting. W. K. GUILFOILE, *Sec'y.*

BRIDGEPORT BRANCH

The Regular Meeting of the Bridgeport Branch was held on November 2 at 8.30 p. m. in the Chamber of Commerce Rooms of the Stratfield Hotel. Al. Rosenthal, president, called the meeting to order. There were thirty members present. The Roll Call of Officers and the minutes of the last meeting were read and accepted.

Ray O'Connor, chairman of the Convention Committee, reported that various meetings had been held concerning the Convention and each committee was making progress in its tasks. The committee reported that the Convention would be held in Bridgeport, Conn. in June from the 10th to the 13th. Mr. George Hogaboom, a most welcome guest, was present, and he spoke on the papers for the convention.

Mr. Raymond Meyer announced that the following would serve in the Research Dept.: Mr. Sexton, Mr. McGar and Mr. Meyer.

The Secretary was instructed to send a letter of condolence to the family of the late Charles Ney.

George Wagstaff, Chairman of the Program Committee presided for the remainder of the evening. Mr. Harry MacFadyen, of the Hartford Branch was the speaker of the evening. He chose for his subject: "The Qualifications of a Foreman," which proved to be most interesting and approved by all present, particularly Mr. Hogaboom who spoke of its excellence. Mr. MacFadyen was tendered a rising vote of thanks. The speaker at the December meeting will be Mr. Hogaboom, whose subject will be: "What's Under the Plate." Members of other branches are cordially invited to attend this meeting.

The door prize, one of which is donated at each monthly meeting, was presented by Mr. Robert Mooney of the Celluloid Zapon Co. Mr. John Schneider, of Stamford held the lucky ticket.

WILLIAM FLAHERTY, *Sec'y.*

NEWARK BRANCH

The regular meetings of the Newark Branch held October 19 and November 2 were both filled with worth while talks.

On October 19, Mr. N. Sievering and Mr. S. Taylor spoke on different methods of anodizing aluminum. Due to the death of Mrs. Proctor, Mr. Proctor's talk of his trip around the world was postponed.

Librarian Nelson Sievering spoke on the anodic aluminum process by the means of sulphuric acid. The different percentages of sulphuric use to secure the hard and soft oxide. Temperature and control of solution and showed samples of work done.

President Mr. S. Taylor spoke on the Chromic Acid treatment of Aluminum and its alloys. The cleaning method and the type of solution used, the smoothness of the anodic film and its resistance to withstand a salt spray test 720 hours.

Both of these talks were good and brought forth much discussion of the comparative results from both methods of anodizing.

On November 2, we had the pleasure of having one of the best speakers in the country, Dr. H. Lukens of the University of Pennsylvania, whose subject was the Mechanism of Conductance. This subject of conductance was one of which a lot of the members of Newark Branch have not the right definition. But Dr. H. Lukens, talk thoroughly cleared up this conductance condition. Sorry that more of the members of Newark and New York Branch members were not present, as it was we had an attendance of 32 at this meeting. This talk was illustrated with lantern slides and defined the different conductance charts between copper and tin and a solution of sodium sulphate. GEORGE REUTER, *Sec'y.*

TORONTO BRANCH

Honest Injun, fellows—if Toronto Branch meetings continue to attract our members as during the past three meetings we shall be obliged to move into larger quarters. Each consecutive meeting has an increased attendance. At our November gathering two new members were elected to active membership and one member reinstated. Seven members were suspended for non-payment of dues and that is something we don't like to do. But, there is a limit to tolerance in all things. Fred Bing presented a splendid paper on "Brass Finishes and their Protection". With reference to spotting out, Fred said he had more trouble with sand blasted surfaces than with water milled surfaces. He exhibited many samples of the various brass fin-

ishes he produces and was ready and willing to tell us how he did the trick. This was Fred's first attempt to present a paper, but he did wonderfully well.

Q. Name a hard wax that will effectively resist muriatic acid solution used as a chrome strip, from attacking a redwood tank?

A. No name supplied. Can any member tell us?

Q. How long will Cadmium remain white without lacquering?

A. Depends on atmospheric conditions to which it is subjected.

Colin Turner and Wm. Boutrell were with us and Harry Creswell is once more a regular attendant. As a result of past experience we shall omit a meeting in December. Xmas holidays and A.E.S. interests fail to combine satisfactorily. But listen — on January 28th, 1935 we expect to have Mr. Geo. B. Hogaboom as guest speaker. The subject of his lecture will be "What is Under the Plate?" Watch for advance notice. Other guests speakers for early dates in 1935 are Prof. J. T. Burt-Gerrans of Toronto University and Dr. R. O. Hull of Cleveland, Ohio. "Believe it or not"— you are missing much of real worth if you do not attend Toronto Branch meetings regularly. W. S. B.

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Bridgeport Branch

Raymond Bruske, c/o W. D. Allen Mfg. Co., 5650 Roosevelt Rd., Chicago Ill.
Active, Chicago Branch

Albert Raml, 2427 N. Francisco Ave., Chicago Ill., Active — Chicago Branch

Ray A. Austin, 1483 Montclair Ave., Detroit Mich., Active — Detroit Branch

G. W. Collins, 1745 Baldwin, Detroit Mich., Active — Detroit Branch

Robt. L. Reed, 2567 Parker Ave., Detroit Mich., Active — Detroit Branch

Jacks D. Clayton, 2842 W. Grand Blvd., Detroit Mich., Associate
Detroit Branch

Leo W. Paul, 3286 E. Fort St., Detroit Mich., Active — Detroit Branch

Lawrence W. Rowley, 6320 E. Fort St., Detroit Mich., Active — Detroit Branch

Delos R. Hay, 2700 Wright St., Detroit Mich. Associate — Detroit Branch

Joseph F. Borrows, South Hampton Rd., Amesbury, Mass. Active — Boston Branch

Wilbur H. Lamie, P. O. Box 447, Forestville, Conn. Active — Hartford Branch

Wm. Arthur Crowder, 622 Clement Ave., Charlotte, N. C. Associate
Baltimore-Washington Branch

Edward Thos. Collins, 650 "H" St. N. E., Washington, D. C. Active
Baltimore-Washington Branch

Henry Paul Miller, 2906 Chesley Ave., Baltimore, Md., Active
Baltimore-Washington Branch

Philip Aloysius Lower, 906 10th St., S. E., Washington, D. C. Active
Baltimore-Washington Branch

Chester G. Bethke, 149 Carroll St. S. E., Washington, D. C., Active
Baltimore-Washington Branch

Gilman L. Parater, Jr., 708 Varnum St. N. W., Washington, C. D. Active
Baltimore-Washington Branch

Lindell L. Turner, 130 "F" St., S. E. Washington D. C., Active
Baltimore-Washington Branch

APPLICATIONS

Floyd Julian Waugh, 14346 Ardmore Ave., Detroit Mich. Active — Detroit Branch

H. Robert Schoenfeldt — Newark Branch

G. Knecht — Newark Branch

G. Berger — Newark Branch

Arnold Anderson, c/o Individual Drinking Cup Co., Easton Penn., Associate
Philadelphia Branch

RE-INSTATED

Howard E. Randall, 5128 Marathon, Los Angeles, Calif., Active
Los Angeles Branch

Leon Moore, Almont, Mich. Active — Detroit Branch

A. S. Arcuri, 4913 Cortez St., Chicago, Ill. Active — Chicago Branch

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The BUYERS' GUIDE

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Meets fourth Monday of each month, at Canadian Foresters' Hall, 22 College St., Room No. 2. Secretary, H. W. Graham, 26 Beatrice St., Toronto, Ontario, Canada.

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Meets second Friday of the month, at Engineers Hall, No. 11 East Main St. Secretary, Wm. F. Guilfoile, 14 Oakland Ave., Waterbury, Conn.

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AS another year comes to a close, we extend to you our best wishes for the Christmas season and for the New Year. We are appreciative of your friendship and of the patronage you have given us. We pledge our best efforts to make MATCHLESS COMPOSITIONS and MATCHLESS SERVICE of even greater value to you.

As the New Year advances may it bring you an increasing measure of prosperity and happiness.

THE MATCHLESS METAL POLISH COMPANY

840 W. 49th Place, Chicago, Ill. — 726 Bloomfield Av., Glen Ridge, N. J.

EXPERIENCED ELECTROPLATERS

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ANACONDA

Copper Anodes

. . . because their unexcelled purity assures uniform corrosion, the highest quality deposit in the shortest possible time and low scrap losses. Furnished with suspension holes drilled as desired, or tapped for end hooks.

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Write for a sample of our new line of METALLIC LACQUER ENAMELS. Furnished in: Gun Metal, Gold, Silver, Bronze and Pastel Shades.

Another item that should interest you is our CHROMIUM PRIMER. Adheres tenaciously to Chrome Plate.

If you have a finishing problem, consult us.

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Why Nickel Plate with a Different Solution for Each Metal?

USE ZIALITE FOR THEM ALL

You may have a solution which nickel plates brass, copper and iron equally well. But does it plate zinc? Unless it is ZIALITE...NO.

ZIALITE, the new nickel plating solution, plates zinc, as well as other metals, in the barrel, and absolutely without black striae! And you do not have to plate zinc and zinc base die castings first with any other metal.

With ZIALITE, you can plate any composite object (of copper, brass, white metal and solder, for instance) and have as smooth a deposit, with as little trouble, as you would with an object of but one metal.

Hollow ware is plated with ZIALITE, with complete coverage, without an inside anode. This means a great saving to you in expense, labor, time, and the elimination of special racking devices.

You can operate ZIALITE at low initial current density—only 7 to 12 amperes per square foot—without depositing nickel by immersion; and, at any current density, you will eliminate black striae entirely. With its remarkably high throwing power, ZIALITE covers the deepest recesses and sheltered places easily and uniformly, without streaking, and without burning the edges and high spots. Because of its close grained and adherent deposit, *it gives a really white nickel deposit.*

When plating zinc, you will find the ZIALITE bath permanent, while the ordinary bath has to be discarded, or re-worked to remove the absorbed zinc, from 3 to 12 times a year ... for ZIALITE definitely retards the solution of zinc and the consequent fouling of the bath. And the chemical maintenance cost of ZIALITE is only $1.60 per thousand square feet of surface area plated.

See for yourself the amazing results to be had with ZIALITE. Send us samples of metals, of the most complicated design, colored for nickel, and we will plate them for you . . . without obligation, of course.

TUTTLE CHEMICAL CORPORATION
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Mail this coupon at once

Trade **Zialite** Mark
Non-Strike Nickel Plating Solution

Tuttle Chemical Corporation
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I am interested in the progress being made in electroplating, and want all the information I can get about Zialite.

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In the realization that a vast percentage of what is sold, is either bought by women or through their influence, industry has wisely recognized woman's search for beauty.

And lacquers . . . among which Zapon is ranked as supreme in quality and economy . . . have made it commercially practicable to provide the beauty that sells . . . incidentally increasing protection against the destructive ravages of time and handling.

You are invited to avail yourselves of the complete laboratory facilities in Stamford and North Chicago

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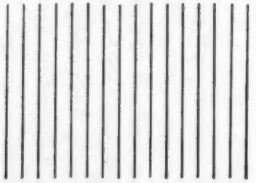

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